

# Study of Bryophytic Flora in the Ramsar Wetland of Merja Zerga (North-west of Morocco)

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**Abstract**—The research undertaken in the IBA and Ramsar wetland of Merja Zerga at Moulay Bousselham were interested only in the higher plants. Our study tends then to contribute to enrich the knowledge about the bryophytic flora of this area by filling the gaps in this field. Thus, we carried out a systematic sampling with a stop and a harvest in each encountered bryophyte population. This prospection enabled us to find 26 species of bryophytes including 22 species of mosses belonging to 15 genera and 9 families, and 4 species of liverworts belonging to 3 genera and 3 families. The relative low specificity of this wetland can be explained by the influence of sea spray and the strong anthropic disturbance. A comparison with previous studies allowed us to conclude that 11 species were observed for the first time in the area.

**Keywords**—Biodiversity, Bryophytes, IBA and Ramsar Wetland, Merja Zerga, Morocco.

## I. INTRODUCTION

Wetlands are among the ecosystems that have been subject to frequent scientific studies. These studies have highlighted these areas and their undeniable role in biogeochemical cycles, especially the water cycle. In Morocco, 38 wetlands are classified as Biological and Ecological Interest Site (BEIS) in the continental domain and 38 wetlands as BEIS in the coastal area (CEIBM, 2016). Among them, 20 are designated as Important Bird Areas (IBA) and 24 as Ramsar Wetlands; Merja Zerga—our study area—is part of both IBA (Interest Biodiversity Area) and Ramsar (Cherkaoui & al., 2015).

Moroccan wetlands, despite conservation efforts, have undergone considerable deterioration that still increasing (Dakki and El Hamzaoui, 1998). According to Hammada et al. (2004), the natural drought, which was very frequent and severe for decades, made the situation far worse.

Water consumption has continued to increase, while water reserves are steadily declining. The frequent drying of habitats throughout the country is compounded by an increase in the salinity of coastal wetlands that are largely invaded by marine waters because of climate change.

Merja Zerga, a wetland listed in the coastal area, is a populated and popular site because of its proximity to the touristic and recreational site of MoulayBousselhame. It copes then with an abusive exploitation such as overgrazing, excessive cutting of reeds that lead to habitat loss (Hammada et al., 2004). Benabid (2000) and Cherkaoui & al. (2015) state that in bird nesting period, the destruction of biotopes of multiplication of avifauna can involve a major disturbance in the life cycles.

According to Dakki and El Hamzaoui (1998), we can distinguish five plant formations from the south of the lagoon to the surrounding dunes: algae and eelgrass, Spartinadensiflora formation, Salicornia halophilous grasslands, Juncusrigidushalophilous grasslands and low lawn. At Drader River, submerged fresh water vegetation (*Myriophyllum*, *Potamogeton*) marks the passage between the lagoon and the fresh waters.

Considered as the most important transit point in Morocco for ducks and other migratory birds (Benabid, 2000), this zone was subject to studies that were interested in the phanerophyte or algal flora (Hammada et al., 2004), but no specific research has been carried out on the bryological flora. The objective of this study is therefore to contribute to the inventory of the species of the bryophytes of Merja Zerga in order to fill the gaps in knowledge.

## II. MATERIALS AND METHODS

### 1.1 Description

Merja Zerga is a wetland belonging to the Gharb basin. It is bounded to the north by Drader River, which drains a

watershed of 1150 km<sup>2</sup>, leads in the lagoon at the end of the main canal and at the delta in the northeastern part of Merja Zerga (Figure 1). In the south, the Nador Canal, built in 1953, drains the M'da watershed over 700 km as well as the right bank of Sebou River (Lamrini et al., 2007). Benhoussa et al. (1999) report that, in addition to Atlantic and continental influence, the freshwater aquifer that levels in several points of the wetland is not negligible.

The lagoon has an elliptical shape and is located at the northwest of the Kingdom of Morocco (34°51' North, 6°16' West). It is composed of two Merjas: MerjaKahla of 3 km<sup>2</sup> in the north with a depth lower than 50 cm at high tide and Merja Zerga of 27 km<sup>2</sup>, with a 9 km of length and 5 km of width (Snoussi and Raji, 2011).

Geologically, Merja Zerga is located between the Atlantic Ocean in the west, the Rif mountains in the north and the Atlantic Meseta at the north-western end of Rharb Basin; it occupies a synclinal flexion of tectonic origin. Two categories of sediment line the lagoon: vases coming from the contributions of Drader River and the Nador Canal in the calm zones and sands of essentially marine origin in the main canal area and at the pass (Bidet, 1977).

According to Gam (2008), the region is under a climate of Mediterranean type subject to oceanic influences; the mean temperature is of 18°C with an important annual thermal variation (26°C). The Merja Zerga lagoon is subjected to micro to mesotidal regime with a tidal range of 0.15 to 1.5 m (Carruesco, 1989).

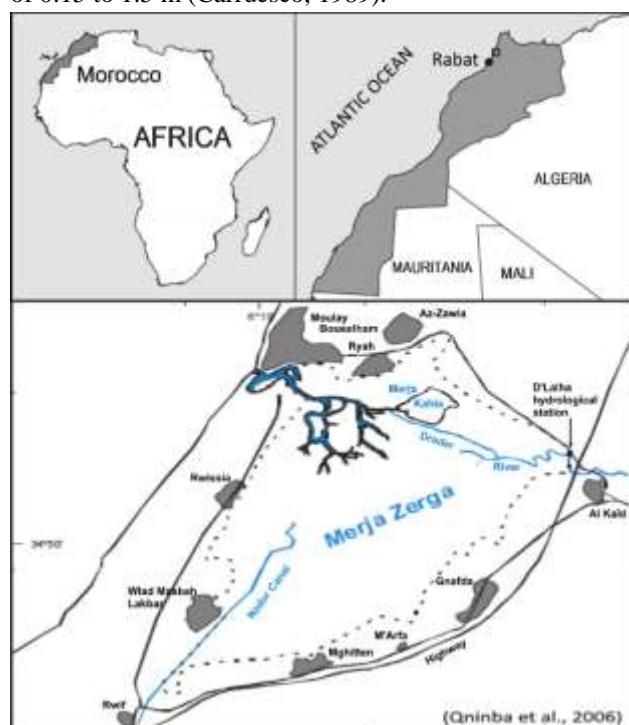


Fig.1: Geographical location (top right) and general physiognomy of MerjaZerga (Qninba et al., 2006 with modifications)

Salinity varies according to seasons and tides. In summer, it can go up to 35 psu; In winter and due to freshwater inputs, it fluctuates between 27 and 30 psu (Labbardi et al., 2005).

Plant groups in the area can be organized by *Phragmites communis*, *Scirpus lacustris*, *Iris pseudacorus*, *Salicornia arabica*, *S. perennis*, *Juncus acutus*, *J. subulatus* (Benabid, 2000).

## 1.2 Work Method

We adopted the systematic sampling: we stopped at each encountered stand and we collect a sample there, taking care not to pick up the entire population in order to preserve the species. Each time we geolocated the waypoint by a GPS tool.

The samples are carefully placed in plastic boxes with a label indicating the date, the number of the sample, the type of substrate and its moisture level evaluated according to the closest water. The identification of the samples was carried out on the basis of morphological, anatomical and histological criteria. We used the following determination keys: Augier (1966); Pierrot (1982) and Smith (2004).

For each species, we have kept a sample in herbarium for later potential verifications.

## III. RESULTS AND DISCUSSION

### 1.1 Recorded species of bryophytes

The identification of the bryophytes of Merja Zerga allowed us to establish a list of 26 species belonging to 9 families (Fig.2).

The family of Pottiaceae is represented by 6 species: *Barbulafallax* Hedw., 1801, *Barbulaunguiculata* (Huds) Hedw., 1801, *Timmiella barbuloides* Brid., 1927, *Tortella flavovirens* (Bruch) Broth., 1902, *Tortulamuralis* Hedw., 1801, *Trichostomum brachydontium* Bruch., 1829. For the family of Brachytheciaceae, we found these 5 species: *Brachythecium collinum* (Schleich.) B.e., 1853, *Brachythecium velutinum* (Hedw.) B.e., 1853, *Brachythecium starkei* (Brid.) B.e., 1853, *Platyhypnidium riparioides* (Hedw.) Dixon, 1934, *Rhynchostegium megapolitanum* (Bland.) B.e., 1852. The Bryaceae are represented by 3 species: *Bryum argenteum* Hedw., 1801, *Bryum capillare* Hedw., 1801, *Bryum pseudotriquetrum* (Hedw.) Schwaegr., 1802 and the Orthotrichaceae by 2 species: *Orthotrichum affine* Schrad., 1801 and *Orthotrichum defluens* Vent., 1882. The family of Funariaceae includes 2 species: *Funaria hygrometrica* Hedw., 1801 and *Entosthodon templeteonii* (Sm.) Schwaegr., 1832. Finally, the families of Grimmiaceae, Leucodontaceae, Fissidentaceae and Dicranaceae are represented each one by a single species, respectively:

*Grimmiaalpestris* Schleich., 1807, *Leucodonciuroides* (Hedw.) Schwägr., 1816, *Fissidenspolyphyllus* Wils., 1851 and *Dicranellasubulata* (Hedw.) Schimp., 1856.

The liverworts are represented by only 3 families (Figure 2): Ricciaceae with 2 species (*Ricciaciliifera* Link, et R.

*sorocarpa* Bisch) and Lunulariaceae and Targioniaceae, with one species for each, respectively: *Lunulariacruciata* (Linnaeus) Dum., 1829 and *Targioniahypophylla* L., 1753.

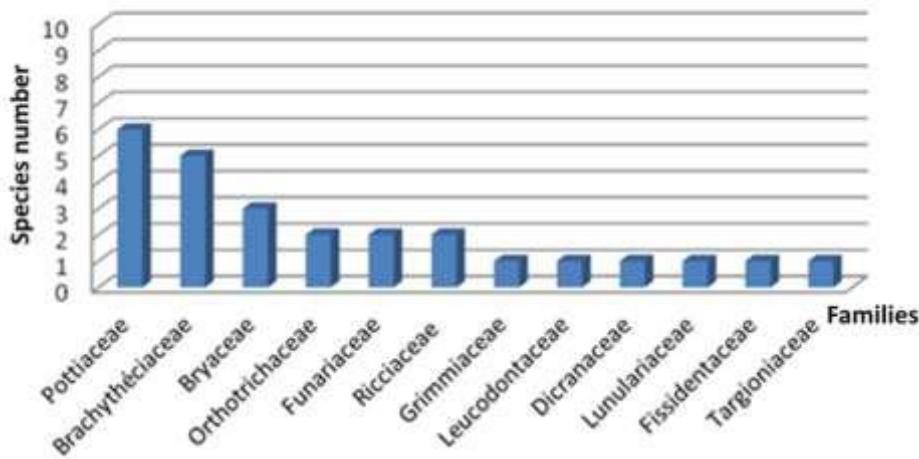


Fig.2: Distribution of families of bryophytes according to their species richness

According to Hosni et al. (2010), the lagoon's waters are contaminated by mineral pollutants coming from about 6 000 hectares of irrigated perimeters that discharge their drainage waters through the Nador Canal and the Drader River.

According to Ayadi (2013), the amount of pesticides applied to the different crops in Merja Zerga territory is 138 666 kg over an area of nearly 39 050 ha, so an overall average of 3.6 kg/ha. This quantity is large enough to explain the low specific richness of bryophytes in the area. In fact, pesticides, especially herbicides applied to crops, are subject to runoff and leaching and this pollution would limit floristic biodiversity in general and bryological biodiversity in particular.

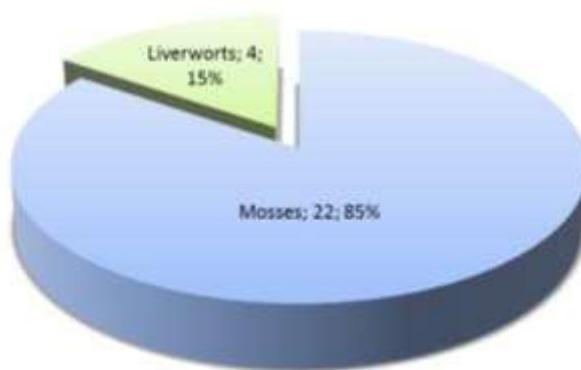
Moreover, the sandy soil, low in organic matter and rich in salt, can only allow the installation of a specific vegetation adapted to this type of environment. This vegetation is mainly nitrophilic due to the important anthropic activities around the Merja and halophilic due to the salt richness of the environment.

Fig.3: Distribution of bryophytes species in the study area

Otherwise, the results show that mosses are the most represented with 85% of the identified species, followed by liverworts with only 15% (Fig.3). We have not found any Anthocerotes species.

We found 7 species on moist soil that remains waterlogged for much of the year: *Platyhypnidiumriparioides* (Hedw.) Dixon., *Rhynchostegiummegapolitanum* (Bland.) B.e., *Fissidenspolyphyllus* Wils., *Ricciaciliifera* Link., *Ricciasorocarpa* Bisch., *Targioniahypophylla* L., *Leucodonciuroides* (Hedw.) Schwägr., and *Entosthodontempletonii* (Sm.) Schwaegr. On the contrary, we found just 5 species on dry soils that are only moistened during rainy days: *Trichostomumbrachydontium* Bruch., *Brachytheciumcollinum* (Schleich.) B.e., *Dicranellasubulata* (Hedw.) Schimp., and *Brachytheciumstarkei* (Brid.) B.e. The remaining mentioned species can be found in all types of environments.

We have noted that some species have a relatively high abundance, case of *Barbulafallax* Hedw., *Barbulaunguiculata* (Huds) Hedw., *Tortulamuralis* Hedw., *Timmiella barbulooides* Brid., *Tortella flavovirens* (Bruch.) Broth., *Brachytheciumvelutinum* (Hedw.) B.e., *Bryumargenteum* Hedw., *Bryumcapillare* Hedw., *Grimmiaalpestris* Schleich., *Lunulariacruciata* (Linnaeus) Dum., *Orthotrichum affine* Schrad., *Orthotrichumdefluens* Vent., *FunariaHygrometrica* Hedw., and *Bryumpseudotriquetrum* (Hedw.) Schwaegr. Others



species have a relatively low abundance such as *Brachytheciumstarkei* (Brid.) B.e., *Platyhypnidiumriparioides* (Hedw.) Dixon., *Rhynchostegiummegapolitanum* (Bland.) B.e., *Leucodontciuroides* (Hedw.) Schwägr., and *Ricciasarocarpa* Bisch. The remaining species are of medium abundance.

The species found in the eucalyptus forest which borders MerjaZerga are *Platyhypnidiumriparioides* (Hedw.) Dixon., *Leucodontciuroides* (Hedw.) Schwägr., *Fissidenspolyphyllus* Wils., *Entosthodontempletonii*. (Sm.) Schwaegr., *Trichostomumbrachydontium* Bruch., *Brachytheciumcollinum* (Schleich.) B.e., *Dicranellasubulata* (Hedw.) Schimp., *Brachytheciumstarkei* (Brid.) B.e., *Barbulafallax* Hedw., *Barbulaunguiculata* (Huds) Hedw., *Tortulamuralis* Hedw., *Timmiella barbuloides* Brid., *Tortella flavovirens* (Bruch) Broth.,

*Brachytheciumvelutinum* (Hedw.) B.e., *Bryum capillare* Hedw., *Grimmiaalpestris* Schleich., *Orthotrichum affine* Schrad., *Orthotrichumdefluens* Vent. and *FunariaHygrometrica* Hedw.

## 1.2 The new species for the region

We compared our findings with the inventory of bryophytes (Ahayoun et al., 2007, 2013) and we noticed that 11 species were encountered for the first time in Merja Zerga (Fig.4). The new species are *Barbulafallax* Hedw., *Brachytheciumcollinum* (Schleich.) B.e., *Brachytheciumvelutinum* (Hedw.) B.e., *Platyhypnidiumriparioides* (Hedw.) Dixon., *Bryumargenteum* Hedw., *Bryumpseudotriquetrum* (Hedw.) Schwaegr., *Grimmiaalpestris* Schleich., *Leucodontciuroides* (Hedw.) Schwägr., *Orthotrichum affine* Schrad., *Dicranellasubulata* (Hedw.) Schimp. and *Orthotrichumdefluens* Vent.



Fig.4: Species newly encountered in the study area: (a) *Barbulafallax* Hedw., complete sample on the left, Capsule with peristome x4.5 and zoom x2 on the right; (b) *Brachytheciumcollinum* (Schleich.) B.e. with moistened branches showing concave leaves x100 on the right; (c) *Brachytheciumvelutinum* (Hedw.) B.e. on the left, leaf x100 on the right; (d) *Platyhypnidiumriparioides* (Hedw.) Dixon. with moistened branch on the left; (e) *Bryumargenteum* Hedw. with moistened branch on the left x100; (f) *Bryumpseudotriquetrum* (Hedw.) Schwaegr. with a leaf x100 on the right ; (g) *Grimmiaalpestris* Schleich., a capsule on the left and a leaf on the right; (h) *Leucodontciuroides* (Hedw.) Schwägr. with a leaf x100 on the right ; (i) *Orthotrichum affine* Schrad., a capsule with peristome on the right; (j) *Dicranellasubulata* (Hedw.) Schimp. with a leaf on the right x100 ; (k) *Orthotrichumdefluens* Vent., a capsule with peristome on the right.

#### IV. CONCLUSION

Our study carried out in the Ramsar wetland of Merja Zerga allowed us to note the presence of 26 species of bryophytes including 22 species of mosses belonging to 16 genera and 9 families, and 4 species of liverworts belonging to 3 genera and 3 families. The mosses represent 85% of the identified species while the liverworts are only 15%.

Over the 26 listed species, 11 were encountered for the first time in the study area. These new cited species are *Barbulafallax* Hedw., *Brachythecium collinum* (Schleich.) B.e., *Brachythecium velutinum* (Hedw.) B.e., *Platyhypnidium ripariooides* (Hedw.) Dixon., *Bryum argenteum* Hedw. *Bryum pseudotriquetrum* (Hedw.) Schwaegr., *Grimmia alpestris* Schleich., *Leucodon sciuroides* (Hedw.) Schwägr., *Orthotrichum affine* Schrad., *Dicranella subulata* (Hedw.) Schimp. and *Orthotrichum defluens* Vent.

We noticed a weak specific richness in the zone that we can explain by the fact that the environment is under the influence of sea spray and subjected to strong anthropic pressure.

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